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9 March 1971

Notes Re: Optical Equipment Test Kit Proposals

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1. Proposal received 8 March 1971.
2. P. 1 - What is phoria? Image runout? See p. 18.
3. P. 4, 5 -- The inter-relationship among accuracy, precision, and repeatability as given is questionable. Precision and repeatability are more closely related than indicated. For example, in figure 1c, I would judge the measurements to have been made to only 2 significant digit precision, since the last digits are not repeatable.
- Question: How do they get "three digit precision" out of "1.042"?
- I could four significant digits.
4. P. 7, 8 -- Why the mixture of inches and microns? This works out to 7.5 lp/mm., a bit on the high side. Optimum illumination? Other optimum conditions?
- *5. P. 11, 14 -- It is questionable whether this wide a range (1-1000) of target frequencies is necessary (why down to 1 lp/mm if the eye can resolve 8 unaided) or feasible (we have no targets in our library which even attempt so wide a range.)
- *6 . P. 15 -- Use of a CdS light meter is inadvisable. Cadmium sulphide is non-linear and shows pronounced past history effects ("fatigue", "hysteresis"). A simple photo-voltic device (perhaps silicon) would be far superior and would eliminate the problems of battery placement associated with CdS meters.

7. P. 16 -- Measurement accuracy is dependent on accuracy of scales,
not precision as defined by
- *8. P. 16 -- Is it valid to substitute a recticle eyepiece for the furnished
eyepiece in order to measure magnification? How is the magnification of
the furnished eyepiece measured?
- *9. P. 17 -- (Pl 13, Item #3) -- This test object for astigmatism does
not seem as useful as the "wagon Wheel" pattern shown in some texts.
- *10. P. 19 -- No mention of spectral sensitivity of light meter. Should
be photopic.
- *11. P. 20 -- Tape measure should be precise to 1/16.
- *12. P. 20 -- Dial caliper, reading to .001, costs only a few dollars more.
- *13. P. 10 -- Tension scale should read to 10 lb.
- *14. P. 22, 23 (Item 23) -- Neutral gelatin filters would not exhibit
Callier effect. Why dyes and carbon?
- *15. P. 25 -- Question that all goodies can be ordered in 30 days from
go-ahead.

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*Indicates major point.

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1. Proposal received 8 March 1971.
2. P. 2 -- Not too keen on all-targets-on-one-roll concept. How is it to be handled when evaluating a microscope only? A Microfiche projector?
3. P.6 -- 1-1000 line target again. In design objective? 1-10 lp/mm seems unnecessary. Why 15 bars for visual target?
4. P. 7 -- Their tape better than - one side in cm.
5. P. 7 -- Prefer inside-outside vernier calipers to leg variety. Can combine depth guage.
6. P. 7 -- New (to me) vibration target. How do you use the concentric circles?
7. P. 8 -- Light source does not provide as well as diffuse illumination. Inferior to item.
8. P. 8 -- Fish scale adequate for tension measurement.
9. P. 9 -- Will 12" x 18" x 5" fit under airliner seat? 25 lbs. is rather heavy to carry to ramp.

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BRUCE
5 MARCH, 1971

MEMORANDUM FOR: Chief, Test and Evaluation Branch

SUBJECT : Critique/Comparison of Optical Test Kit
Technical Proposals [REDACTED]

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1. Overall Considerations

First, the [REDACTED] Proposal includes a significant amount of details concerning the characteristics of the various optical tests, whereas the [REDACTED] Proposal is somewhat lacking in detail.

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Second, the [REDACTED] Proposal lists more optical tests which seem to be of importance.

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2. Comments/Questions on [REDACTED] Proposal

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a. No test for focus capabilities was listed. This item has an apparent need for some means of testing.

b. The use of a diopter telescope is proposed for making resolving power tests. One text mentions "Resolution of a photographic material is not measurable apart from the other components of the photographic process." This must mean that the resolution readings are for the entire system, including (1) target, (2) illumination method, (3) optical elements, and (4) read-out method. [REDACTED] when asked about using external viewing aids for use in resolving power tests, was somewhat hesitant to say what the "proper" test should include or exclude. It may be beneficial to obtain the justification for or against use ~~justification for or against use~~

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of the diopter telescope.

c. The use of a glass resolving power target is mentioned, however in some cases the range of instrument focus is insufficient to use a (thick) glass target when the target side is toward the objective. A film target may be of some use.

d. The test for orthogonality can apparently resolve measurements to 0.5 minutes of arc, however, the specification on the 6X6 Mann Comparator were in the order of 5 seconds of arc. Possibly a finer grid would be necessary, which could resolve angular measurements of a smaller magnitude.

e. Some of the wording which describes precision, accuracy and repeatability is confusing. For example, under the test item #3, p. 13, Astigmatism and Orthogonality Target, the precision is stated as "orthogonality to better than 0.5 minutes of arc." In paragraph C on page 21, the accuracy is stated as "It will similarly check out orthogonality with an accuracy down to 0.5 minutes of arc." Does this mean that if an angle of .5 minutes of arc were being measured that if one measurement were taken the measured value would be 0.5 ± 0.5 minutes? It seems that a more meaningful way to express these terms is to use the terms resolving power (smallest measurement resolved), accuracy (closeness to true value) and precision (repeatability of measurements). Accuracy should be expressed as some percent of the value read, and precision as some form of standard deviation, as the probable error = .674 σ which yields a probability that the random error lies between -.674 σ and +.674 σ is .50.

f. Although it was not mentioned in great detail the contents of the instruction manual, a section on statistical procedures, hypothesis testing and sampling plans would seem beneficial. If a system is borderline some sort of a hypothesis test is the reasonable way to arrive at a decision whether the instrument is in or out of specification.

3. Comments/Questions on Proposal

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a. On page 5 a 25 foot test film is discussed. Wouldn't this be too bulky in some applications?

b. On page 6, paragraph 2.1.6 the maximum reading power of the target is 228 lp/mm, which seems somewhat low for our current needs.

c. According to MIL-HDBK-141, paragraph 26.1.2.3, the contrast of a resolution target effects the resolving power measurements. "Again we must warn that if the lens is to be actually used on low contrast targets, then we had better check it on low contrast targets." What is the reason for not including low contrast targets?

d. Paragraph 2.2.3 on page 7 discusses test grids as being part of the test film. Would it not be necessary to have small separate test grids also?

4. Conclusions

For the prices, listed, both proposals seem to offer less than expected. In reality, a test kit could be formed in-house for considerably less cost. If a choice must be made between the two, however, the Proposal ^{probably} offers more for the money.

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